PATENT SPECIFICATION

Inventor: CHESTER E. HOCKERT **790,350**

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International Classification:—F01d.

COMPLETE SPECIFICATION

Improvements relating to Elastic-Fluid Turbine Wheels and the Attachment of Blades thereto

We, GENERAL MOTORS CORPORATION, a Company incorporated under the laws of the State of Delaware, in the United States of America, of Grand Boulevard, in the City of Detroit, State of Michigan, in the United States of America (Assignees of CHESTER E. HOCKERT) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to elastic fluid turbines, and more particularly is concerned with improving the attachment of the blades to the turbine wheel so that fatigue failures at or adjacent to the attachment points may be avoided or rendered less possible.

The scope of the invention is defined by the appended claims; how the invention may be carried into effect is particularly described below with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal sectional view of a portion of a gas turbine engine embodying a turbine wheel and blade assembly in accordance with the invention;

Figure 2 is an enlarged sectional view of a portion of the wheel and blade assembly of Figure 1 taken on the plane indicated in Figure 3;

Figure 3 is an enlarged fragmentary face view of the wheel and blade assembly of Figure 1 taken in the direction 3—3 of Figure 5;

Figure 4 is a fragmentary view partly in section taken in the direction 4—4 of Figure 3; and

Figure 5 is a plan view of a portion of the turbine wheel rim.

Referring to the drawings, Figure 1 illustrates the turbine portion of a gas turbine engine embodying a turbine wheel and blade assembly in accordance with the invention. The turbine 10 comprises a stator 12 and a rotor 14 which are shown disposed between the discharge end of the combustion apparatus 16 and the turbine exhaust casing 18 of the engine. The turbine stator 12 is supported from the interior of the engine by an annular frame 17 and comprises a flanged inner ring 22 and a stepped outer ring 24 between which is mounted an annular row of circumferentially-spaced stator vanes 26. The outer ring 24 is supported from the inner ring 22 by the vanes 26 and supports the turbine exhaust duct 18 and a flanged casing 28, which surrounds the discharge end of the combustion apparatus 16 and turbine 10, as shown.

The turbine rotor 14 comprises a wheel having a disc portion 32 and a rim portion 34 with an integrally formed hollow shaft 36 that extends axially from the hub or central portion of the wheel. The portion of the shaft adjacent the forward face of the wheel is supported by a bearing 38 mounted in the frame 17. A seal 39 prevents escape of lubricant from the bearing. A tie bolt 40 secured by a nut 42 passes through the interior of the hollow shaft 36.

The turbine wheel mounts a row of turbine blades 46 spaced about the periphery of the rim portion 34. Each blade is an integrally formed element comprising an aerofoil portion 48, a platform portion 50, and a wedge-shaped enlarged root portion 52 as shown in Figure 2, 3 and 4. As best shown in the plan view of Figure 5, the aerofoil portion 48 has one convex and one concave face and is twisted throughout its length. The platform portion 50 is shown as a parallelogram with parallel ends 57, 58 and side faces 59, 60 that overhang beyond the corresponding ends and side faces of the aerofoil portion, the base of the latter being smoothly united to the upper surface of the platform by fillets 61 (Figures 2, 3 and 4). The root 52 is of V-shape with serrated side faces 63, 64 (Figure 3), which converge downwardly from the lower surface of the platform 50, and spaced flat ends 65, 66 which are smoothly united with the platform portion

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by fillets 67 under the ends of the latter.

The blades are slidably mounted in circumferentially-spaced V-shaped slots having side walls 69, 70 (Figure 3) which extend somewhat obliquely across the wheel rim, the depth of the slots being such that the periphery of the wheel extends above the top dovetail root serration just below the blade platform. The blade roots are loosely fitted in their slots to permit slight movement thereof for vibration damping. The side walls of the slots are serrated to mate with the serrations on the side faces 63, 64 of the blade root so as to prevent radial movement of the blades. Each of the latter is retained in the wheel by a retaining pin 72 (Figure 4) which is driven through a boring 73 in the wheel into a registered boring 74 in the blade root, as shown.

The length of the platform 50 is equal to or slightly greater than the chord length of the aerofoil 48 which, in many cases, is of greater length than the slots in the turbine wheel rim so that the aerofoil and platform portions overhang the root, as shown in the drawings. The blade, therefore, is of "notched" section and of reduced tensile strength by reason of the stress concentrations appearing in the "notched" region thereof. The corners between the ends 65, 66 and side faces 63, 64 of the blade root constitute stress raisers where fractures are first likely to develop if the loads exerted on the blade exceed the fatigue limit thereof.

The wheel rim 34 is of tapered section to expose or extend the ends 65, 66 of the blade roots beyond the tapered faces 80, 81 of the wheel rim. Chamfers are provided along the serrated corners or edges between the ends and the side faces 63, 64 of the blade roots. The axial thickness of the wheel at its periphery is made less than the length of the blade root in the direction axially of the wheel where the root engages the wheel rim, by tapering the thickness of the wheel rim radially outwards towards the periphery thereof, through a radial distance preferably at least equal to the depth of the blade root slots.

The corner chamfers mentioned above are shown in Figure 3 as flat bevel surfaces 83 between the ends and side faces of the blade roots at about 45° to the planes of the side faces of the roots. The width of the chamfers or bevel surfaces 83 is preferably such that the bevel surface extends beyond the bottoms of the serrations in the side faces of the roots.

By providing a wheel rim of tapered section, the torsional and centrifugal loads exerted on the ends of the blade roots are removed from the end portions of the latter extending beyond the tapered faces of the wheel rim and are concentrated toward the central portion thereof, thereby increasing the blade load carrying ability and reducing the peak level of stresses in the vicinity of the "notched" section of the blade. Chamfering the corners of the roots eliminates the stress raisers formed by sharp corners, and hinders the development of fatigue fractures.

What we claim is:—

1. A bladed elastic-fluid turbine rotor wheel having its blade roots anchored in undercut slots extending from one end face of the wheel to the other; the wheel rim being tapered in thickness in a radially outward direction so that its peripheral thickness is less than the length of the blade roots in the direction axially of the wheel; and the corners of the blade roots, formed by the meeting of the ends and side faces thereof, being chamfered.

2. A rotor wheel according to Claim 1, wherein the aerofoil portion and the root, of each blade, are separated by a blade platform which overhangs the root.

3. A rotor wheel according to Claim 2, wherein the undercut slots and the corresponding roots, are substantially of V-shape with serrated side faces.

4. A rotor wheel according to any preceding claim, wherein each blade root is secured against axial movement in its slot by a pin engaged in registered borings in the wheel rim and the root respectively.

5. A bladed elastic-fluid turbine rotor wheel having its blade roots anchored in undercut slots; the wheel rim being tapered, and the corners of the blade roots chamfered, substantially as hereinbefore particularly described with reference to the accompanying drawings.

E. WILLIAMSON,
Chartered Patent Agent.

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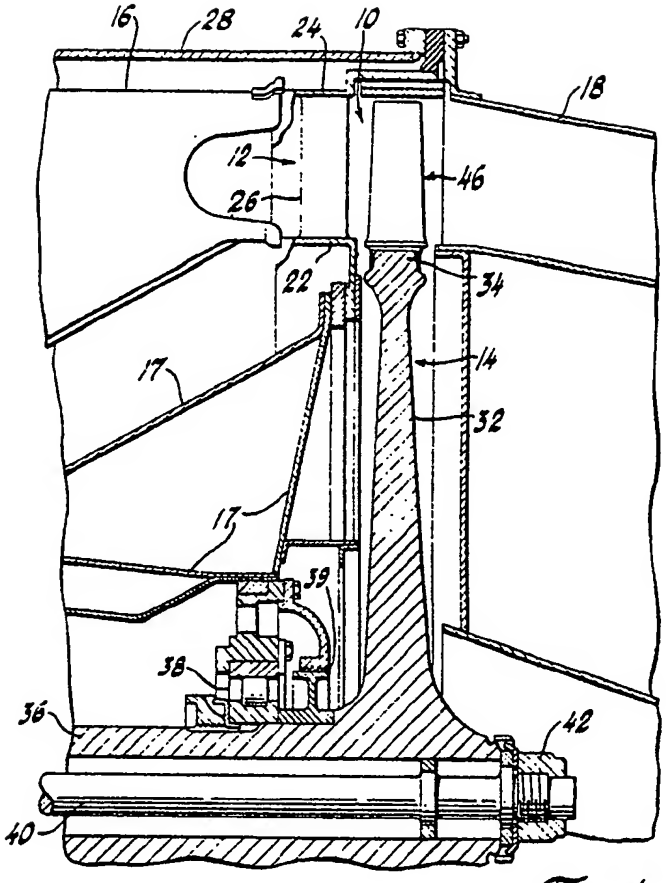

Fig. 1

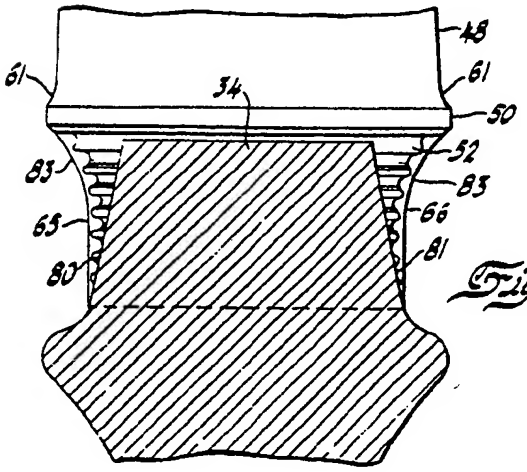

Fig. 2

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2 SHEETS

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SHEETS 1 & 2

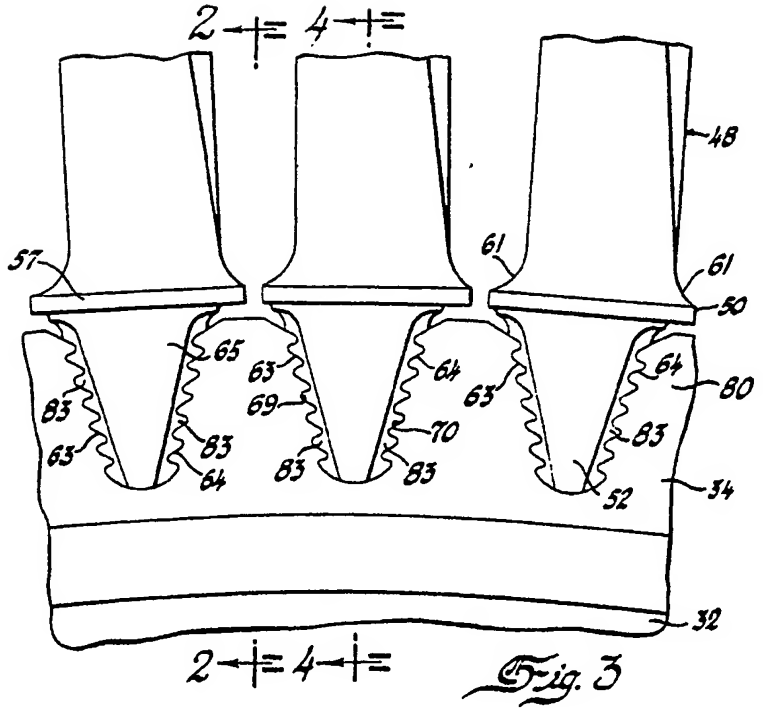

Fig. 3

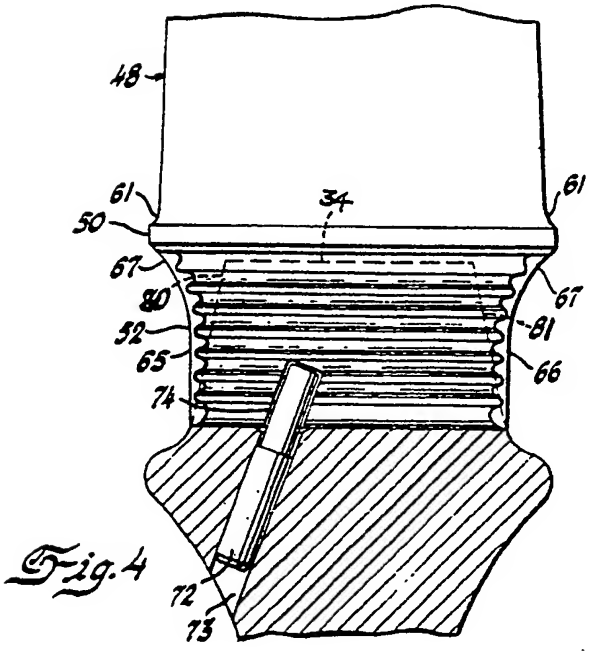

Fig. 4

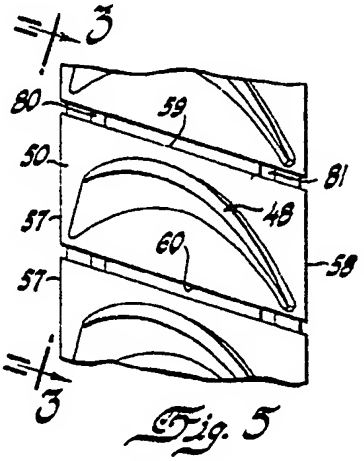

Fig. 5

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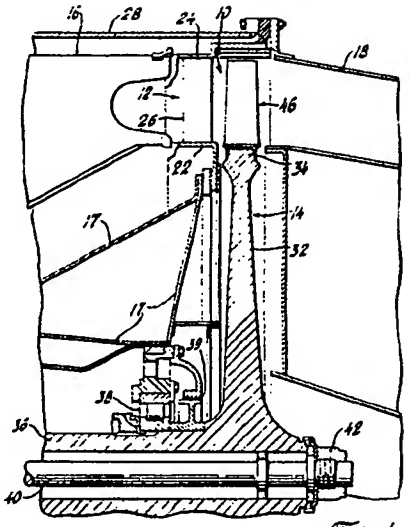

Fig. 1

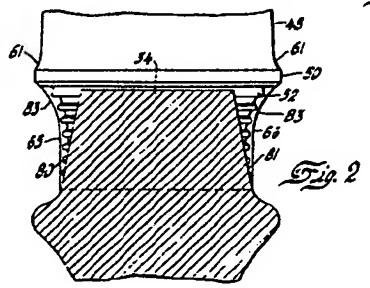

Fig. 2

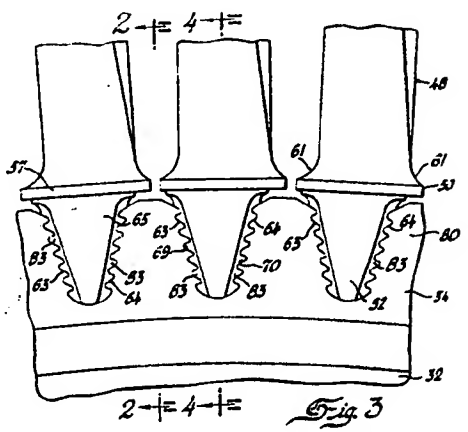

Fig. 3

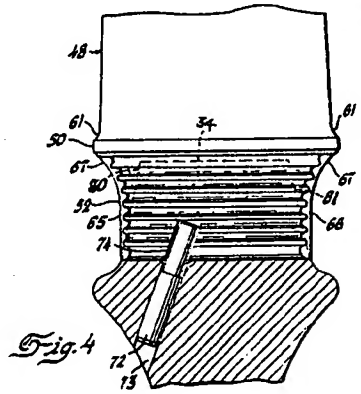

Fig. 4

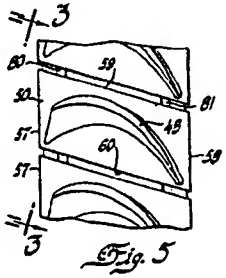

Fig. 5

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